NOTE:
To insure all warranties expressed or implied are allowed, it is important that the unit be installed and calibrated per this manual. Follow all instructions starting in SECTION 1.0 on page 1 concerning verifying equipment and operation, installation instructions, notes and wiring instructions.
1.3 Application to Magnetic Flow Measurement

In a magnetic flowmeter the liquid acts as a moving conductor as it flows through the pipe. The induced voltage (E) in the liquid is measured by two sensing electrodes mounted opposite each other in the meter sensing head.

The length of the conductor is equal to the distance between sensing electrodes and also the internal diameter (D) of the pipe. The flux density is proportional to the coil current (I), times a constant (k). The above formula can be restated as follows:

\[ E = I \times k \times D \times V \]

\[ V = \frac{\text{flow}}{\text{cross sectional area}} = \frac{Q}{A} \]

\[ E = \frac{Q \times I \times 4 \times k}{D^2} \]

Note that if I is held constant, E is proportional to Q or *the induced voltage is directly proportional to the average flow rate (V).*
1.4.1 Electrochemical Interference

The signal voltage is measured by two electrodes. Galvanic elements form on the surface areas between the ion-conducting liquid and the metal electrodes. The polarization voltages which result are dependent on temperature, pressure, and the chemical composition of the electrodes and liquid. These are direct voltages which cannot be predicted and which can be different at each electrode. The signal voltage must be separated from the interference direct voltage. Proper grounding eliminates these unpredictable voltages from interfering with the signal voltage.

1.4.2 Induction Interference (Quadrature)

Electrode cables connect the electrodes with the meter electronics. Because these cables must run within the magnetic field, a voltage is induced which is proportional to the rate of change of the magnetic field strength. The meter design minimizes the length of conductor within the magnetic field in order to keep the value of this interference as low as possible.

1.4.3 Pulp Noise

Liquids which contain pulp such as paper stocks or food mixtures can create high levels of electrode interference voltages as the pulp contacts the electrode. The TIGERMAG™ utilizes a suppression technique by which these interference voltages are rejected if they create an electrode signal which varies excessively from the immediately preceding signal.

This feature compares each sampled flow signal to the previous signal. Signals which vary from the preceding signal by more than 0-30% (selectable) are rejected. This feature provides a stable output during the cycles when spurious signals are interfering, yet permits rapid response to true flowrate changes.

In Figure 1.2, signals at 2, 3 and 4 are outside the tolerance band. A stable output of the signal at 1 is produced and held at that value until two successive signals are within the change tolerance, as occurs at 5.

In Figure 1.3, signal 3 is within tolerance when compared to signal 2. The new output is displayed at 3, a delay of only two coil cycles. This rapid response permits the meter to be used on rapidly changing flows even when the noise rejection feature is used.

This feature permits the use of the TIGERMAG™ automatic zeroing pulsed DC magmeter in applications which had previously required AC meters. See Noise Suppression in the Appendix 1, Programming, section 1.9.4.
1.4.4 Other Interference Voltages

Pipes and the liquids within them are often used as a conductor for electrical grounding. This creates a voltage potential between electrodes which can be high relative to the signal voltage. Proper grounding of the flowmeter to the liquid is necessary to achieve correct meter operation. Grounding rings should be installed if the flowing medium has a voltage potential, if piping is non-conductive (plastic or lined) or if conductivity is below 20 micromhos/cm. See Section 3.8 – Grounding.

1.5 System Operation

The Sparling TIGERMAG™ uses the autozeroing, bi-polar, pulsed-DC measuring technique. The circuitry in Figure 1.4 energizes the coil with 80 mA of current at approximately 20 Hz. The signal generated at the electrodes is measured near the end of each measuring cycle to eliminate the capacitive effects of coatings. The Hi-Z ($10^{12}$ Ω) input impedance eliminates the resistive effects. The field current alternates to a positive and negative state and the two measured signals are averaged to eliminate the effect of a zero offset—auto-zeroing.
The TIGERMAG™ incorporates automatic gain control. Electrode signals are automatically amplified to maintain proper signal levels at all flows. This makes accurate flow measurement with the display and with the pulse or frequency outputs completely independent of the settings of full scale. Rangeability of these outputs is in excess of 100:1 (from 0.3 feet per second to 33 feet per second). Rangeability at stated accuracies is 33:1 when the minimum velocity of 1 foot per second is maintained.

1.7.1 Sensor

The FM625 consists of a ceramic or Tefzel® lined stainless steel sensor which is shrink fitted into a cast aluminum or optional steel housing. The FM655 flow sensor is a welded fabrication of 304 stainless steel, fitted with two carbon steel flanges. The flow sensor contains a non-conductive liner of ceramic, polyurethane, Tefzel®, hard rubber, soft rubber, or neoprene. Both TIGERMAGS™ are structurally sound waterproof assemblies capable of handling a wide range of highly corrosive and abrasive liquids.

Fused platinum electrodes, standard on ceramic meters from 0.1” to 4”, require no O-rings, eliminating a potential fluid path. Platinum is suitable for nearly all conductive liquids. The electrodes in all other liners are self-sealing.

All internal cavaties of the FM625 sensor housing are filled with a high temperature silicone potting compound to prevent the possibility of moisture damage and to avoid the possibility of collection of explosive gases.

▼ WHEN PROPERLY CONNECTED WITH LIQUID-TIGHT CONDUIT, THE REMOTE FM625 FLOW SENSOR WILL WITHSTAND ACCIDENTAL SUBMERSION. SEE FIGURE 3.17.

1.7.2 Transmitter

The transmitter is housed in a CSA and Factory Mutual approved, NEMA-4X and NEMA-7 instrument enclosure. The power and signal electrical connections are made in a separate section of the housing which is isolated from the electronics.
Specifications

Power Requirements

Fuses

See Nameplate

Slo-Blo (12-60 Vdc) ................................................... 2.0 amp
Slo-Blo (77-265 Vac) .................................................. 1.0 amp
Spare fuse provided (see figure 3.9)

Wire Size

Power .......................................................... 16 AWG; 14 AWG Max
Signal ........................................................... 18 AWG

Ground Cable

Third wire ground of power cable

Accuracy

(Frequency Output)

±0.5% of rate
(1-33 fps) 1"-72" ± 0.01 ft/sec. below 1.0 ft/sec.
± 0.01 fps below 1.0 fps (Frequency output)

± 1% of rate
(1-33 fps) for units smaller than 1"

Reference

25°C, 6 fps full scale. Temperature effect, 0.025% Full Scale/°C.

Conditions

Voltage effect, 0.3% Rate. Accuracy statement based on digital outputs

Repeatability

Within ± 0.1% full scale

Power Consumption

Less than 11 VA

Output Signals

Simultaneous isolated analog and digital
Analog: 0 to 20 or 4-20 mAdc into 800 ohms max.
Digital: Scaled pulse or frequency (selectable)
  a. Scaled, 24 Vdc pulse with 25/50/100 ms on-time width, 0-10 Hz max into 150 ohm impedance min.
  b. Scaled frequency, 15 Vdc square wave, 50/50 duty cycle, 0-1000 Hz max.

Note: Either (a) or (b) with transistor open collector to common, jumper selectable.

Fault

Open collector. Active on self test failure, empty pipe and during programming.

Input Signal

Positive zero return (PZR). Connect to remote dry contact to drive analog and digital outputs to zero when an empty pipe condition can occur.

Minimum Conductivity

5 micromho/cm
The TIGERMAG™ transmitter is designed to be used with any FM625 or FM655 sensor. Electronics are completely interchangeable. Each electronics module is software configured to the sensor. FM655 0.5”- 4” sizes have the same face to face dimensions as FM625 wafer-style meters (0.5”- 4”) See Figure 1.5.

Specifications

Flow Direction
Open collector (rating: 100mA at 30 Vdc). Active in reverse flow.

Full Scale Velocity Ranges
0-3 to 0-33 fps (0-1 to 0-10 mps)

Ambient Temp Limits
-20° to 140°F (-30° to 60°C) (Display may darken above 150°F)

Process Temp
Integral Mount
Hard rubber, Soft rubber, Neoprene, Polyurethane .... -40 - 180°F
Tefzel®, Ceramic: .......................................................... -40 - 212°F

Remote Mount (opt)
Tefzel® (to 300 psi), Ceramic: ...................................... -40 - 266°F

High Temp Coils (opt)
Tefzel® (to 100 psi) .......................................................... -40 - 300°F
Ceramic: .................................................................. -40 - 420°F

Temperatures above 212°F (100°C) require mounting the electronics separately (maximum distance 15 feet at liquid conductivity of 5 micromhos and minimum velocity of 1 fps).

Storage Temp Limits
-20° to 140° F (-30° to 60° C)

Construction
Metering Tube ............ Model 625 – Cast Aluminum (Steel optional)
Model 655 – 304 SS welded, epoxy coated

Flanges .................................................. Carbon steel ANSI compatible

Lining .......................... Model 625 – Aluminum Oxide 99.5%, Tefzel®
Model 655 – Polyurethane, Aluminum Oxide 99.5%

Ceramic: .......................................................... -40 - 420°F

Electrodes .................................... Fused Platinum - Ceramic Liners
316 SS - All other Liners. Others as required

Housing (XMTR) ............... Cast Aluminum, Hi-build Epoxy Coated

Protection rating ......................... NEMA-4X, NEMA-7

Electrical rating
General Purpose
FM Approved* for Class I, Division 1, Groups B, C, D;
Class II Groups E, F, G
CE Rated

Hazardous Locations
CSA Approved* for Class 1, Division 2, Groups A, B, C, D
Cenelec (optional)

*FM and CSA applies to integrally mounted transmitters up to 150 psi only.
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<td>6.0 150</td>
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<td>42.0 1050</td>
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<td>69.88</td>
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<td>60.0 1500</td>
<td>65.50 N/A 73.00</td>
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<tr>
<td>66.0 1650</td>
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<tr>
<td>72.0 1800</td>
<td>72.75 N/A 86.50</td>
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<td>90.00</td>
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<td>89.75</td>
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</tr>
</tbody>
</table>

Note 1: Dimensions and chart values for 150 lb. flanges (ANSI template). Allow 1/8” to 1/4” for liner.

Note 2: Allow 1/4” for 0.5 to 6” meters and 1/2” for 8” and larger meters for grounding rings and gaskets.
2.0 Pre-Installation

2.1 Receiving & Inspection

When the equipment is received, the outside of the package should be inspected for damage. If any damage or shortage is found, notation to that effect should be made on the carrier’s delivery receipt.

Visually inspect the sensor and transmitter for damage from rough handling or faulty packaging. If concealed damage is discovered, notify the delivering carrier at once and request an inspection. Confirm telephone conversations in writing. If inspection is not made, prepare an affidavit stating that you notified the transportation company and that they failed to inspect. Save containers and packaging material.

It is essential that the carrier be notified within 15 days from the date of delivery in order to be in a position to present your claim. Make your claim promptly.

Unpacking and handling of TIGERMAG™ Magnetic Flowmeters should be consistent with the procedures used to handle field instruments.

2.2 Storage

This equipment should be stored in a clean, dry environment. Do not store outside in an unprotected area. Observe the storage temperature requirements. Unpowered storage should not exceed two years.

2.3 Return of Equipment

Obtain an RGA (Returned Goods Authorization) number from the factory prior to returning any materials. The RGA number should be marked on the outside of the package. Failure to obtain authorization will unnecessarily delay any work to be performed at the factory.

3.0 Installation

3.1 Application Considerations

The TIGERMAG™ can be used to accurately measure the volumetric flow rate of liquids having a conductivity of at least 5 micromho/cm.

The presence of entrained air or gases in the process liquid will not prevent meter operation, but will produce a positive (+) error equal to the % by volume gas entrainment.

▼ FULL SCALE FLOW RATES SHOULD BE SELECTED ABOVE 3 FEET PER SECOND (1 METER PER SECOND) FOR BEST ACCURACY.
3.2 Site Selection

Select a pipe location which will always be full of liquid. The equipment should be located where the flowmeter will be accessible for adjustment. Provide a minimum of 18" clearance to the electronics enclosure.

The meter may be located in any position from vertical to horizontal. Flow may be in either direction through the meter. Vertical installation with the liquid flowing upwards, minimizes the possibility of slurry separation and assures a full pipe condition.

Horizontal installation requires that the sensing electrodes be positioned in the horizontal plane. See Figure 3.7.

Provide at least three pipe diameters of straight piping approach between an upstream elbow and the midpoint of the meter. In small meters this can be achieved within the meter itself. More straight approach should be provided after valves or multiple elbows. Provide at least 10 diameters after expanders or laterals which are smaller diameter than the line size.

3.3 Rotating the Transmitter Display

The transmitter can be rotated 90 degrees in either direction. **Do not rotate the transmitter more than 90 degrees in either direction.** See Figure 3.2. Loosen the lock nut securing the transmitter to the standoff. Rotate the transmitter by hand in the desired direction. Tighten the lock nut to prevent further rotation and to prevent moisture entering the enclosure.

Additional rotation can be achieved by removing the meter from the line and reversing the flow through the meter. Excessive rotation of the transmitter can damage internal wiring. **Do not rotate the transmitter more than 90 degrees in either direction.**

▼ **DO NOT ROTATE THE SENSOR JUNCTION BOX ON PERMANENT SUBMERSION PROOF METERS. WIRING WILL BE DAMAGED AND WARRANTY WILL BE VOIDED.**
The line must be de-pressurized and drained in order to check and replace the removable electrodes.

### 3.4 How the Design Works

This design utilizes electrodes which are installed through an accessible parts provided on the sensor body. Electrodes are sealed using two o-rings. One o-ring acts as a primary seal while the other is a back-up seal. This redundant sealing approach provides positive sealing.

To withdraw the electrodes, process line has to be de-pressurized and drained. The outer cover must be removed by unscrewing cap bolts using an 11/32 nut driver to allow access to the electrode cavity. Remove cables from electrodes by removing nuts and lock washers. Using a 3/4" socket, unscrew and remove electrode assembly.

### 3.4.2 The Need for Replacement

Sparling’s flowmeter design utilizes High Impedance circuitry (Hi-Z) which is not affected by coating build-up on the electrodes. Replacement of the electrode only becomes necessary when physical damage due to erosion or corrosion has occurred.

Sparling’s optional hot-tap removable electrode design allows the inspection or replacement of electrodes without stopping the flow or depressurizing the line. The electrode assembly is sealed with multiple o-rings to maintain isolation from the pressurized medium. During removal of the electrode, a stainless steel ball valve is closed to keep the process fluid from leaking out while the electrodes are inspected or cleaned. The electrode housing, wired as a backup electrode, functions as a redundant electrode assembly providing the flow signal to the electronics. In other words, even when the electrode is withdrawn, the flowmeter keeps on providing important flow information.
3.5 Electrode Removal

1. Use a phillips screwdriver to remove the screw and lockwasher from the handle.
2. Gently remove the electrode cable (orange wire) and place aside.
3. Secure cable then loosen the side knob.
4. Using the handle on the electrode head, pull electrode straight to the point that the valve can be closed.
5. Close the ball valve clockwise.
6. Unscrew the hex plug from the valve counter-clockwise and remove the electrode assembly.

3.5.2 Electrode Installation

1. Install hex plug clockwise. Seal tight into closed valve assembly.
2. Open ball valve counter-clockwise.
3. Push electrode assembly in, aligning the slot in the cover with the screw, until firmly seated.
4. Tighten the side knob.
5. Place electrode cables on handle.
6. Install the lockwasher and screw, tighten.
7. Replace gasket, cover, cover screws and tighten securely.

---

• Avoid scratching or damaging the withdrawn electrode.
• Ball valve must be closed before the hex-head electrode assembly is unscrewed and removed.
• Electrode hex-head assembly must be replaced and secured tightly before opening the ball valve and re-inserting the electrode.

3.5.3 When to Replace

Sparling’s flowmeter design utilizes High Impedance circuitry (Hi-Z) which is not affected by coating build-up on the electrodes. Replacement of the electrode only becomes necessary when physical damage due to erosion or corrosion has occurred.
3.6 MODEL FM625 FLANGELESS (WAFER) SENSOR

The flangeless sensor is installed between two process pipe flanges. The sensor contains a non-conductive ceramic or Tefzel® liner. The integrity of this liner must be maintained for the flowmeter to function. **CARE SHOULD BE TAKEN DURING INSTALLATION TO INSURE THAT THIS LINER IS NOT DAMAGED.** Depending upon meter size, four (4) or eight (8) Sparling supplied steel bolts are required for installation of the FM625 between existing flanges. See Table 6. Gaskets are required between the meter and the pipe flanges and between grounding rings and the mating surfaces.

Install the two bolts at the bottom of the meter. Place the meter temporarily between the flanges to confirm correct positioning. The meter should rest directly on the bolts. Remove the meter.

▶ REINSTALL THE METER TAKING CARE TO KEEP THE GASKET CENTERED. Install all bolts and tighten finger tight. Complete installation with torque wrench. It is important that the bolts be tightened alternately so that excessive force is not applied to a concentrated point. See Figure 3.5. **Do not exceed the torque limits in Table 6.**

MODEL FM655 FLANGED SENSOR

The flanged sensor is installed between two process pipe flanges. The sensing head tube interior is covered with an electrically non-conductive liner which overlaps the flange seal surfaces. The integrity of this liner must be maintained for the flowmeter to function. **CARE SHOULD BE TAKEN DURING INSTALLATION TO INSURE THAT THIS LINER IS NOT DAMAGED. FLANGE GASKETS MUST BE USED.** On sizes 0.5” to 4”, four (4) or eight (8) Sparling supplied steel bolts are required for installation of the FM655 between existing flanges. Gaskets are required between the meter and the pipe flanges and between grounding rings and the mating surfaces.

Support the meter between the existing flanges. Install the two bolts (bolts 2 & 3 in Figure 3.5) at the bottom of the meter. Confirm correct positioning of the meter and ensure the gaskets are perfectly centered. Remove the meter.

▶ REINSTALL THE METER TAKING CARE TO KEEP THE GASKET CENTERED. Install all bolts and tighten finger tight. Complete installation with torque wrench. It is important that the bolts be tightened alternately so that excessive force is not applied to a concentrated point. See Figure 3.5 & Figure 3.6. **Do not exceed the torque limits in Table 6.**

![Installation Utilizing Sparling Supplied Hardware](Figure 3.5)
**3.7**

Sparling provides carbon steel mounting hardware (bolts, nuts and washers) with all meters sized 0.1" to 4". Gaskets are provided for ceramic sensors only.

Optional 304SS mounting bolts for these sizes are available at extra cost.

**FM655 meter sizes 0.5" - 4" have the same face-to-face dimensions as FM625 wafer-style meters (0.5" - 4") See Figure 1.5.**

Gasket material should be selected which is compatible with the piping and process conditions. The table below contains typical satisfactory gasket materials. Do not use spiral wound metal gaskets as they may cause liner damage.

**Table 4 – Gasket Material**

<table>
<thead>
<tr>
<th>LINER MATERIAL</th>
<th>GASKET MATERIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ceramic</td>
<td>Teflon®</td>
</tr>
<tr>
<td>Tefzel®</td>
<td>Teflon® Coated Asbestos</td>
</tr>
<tr>
<td>Hard or Soft Rubber</td>
<td>Asbestos Neoprene Rubber</td>
</tr>
<tr>
<td>Neoprene</td>
<td>Asbestos Neoprene Rubber</td>
</tr>
<tr>
<td>Polyurethane</td>
<td>Asbestos Neoprene Rubber</td>
</tr>
</tbody>
</table>

The gaskets, meter flanges, and mating pipe flanges should be dusted with gasket talc prior to installation to prevent damage to the liner should it be necessary to remove the meter from the line. **DO NOT USE GRAPHITE TO DUST THE GASKET. A CONDUCTIVE FILM WILL COAT THE METER INTERIOR AND CAUSE A MALFUNCTION.**

Do not exceed the torque limits in Table 6.

**Table 5 – Meter I.D.**

<table>
<thead>
<tr>
<th>Nominal I.D.</th>
<th>Actual I.D.</th>
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</thead>
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<td>Ceramic</td>
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<td>in mm</td>
<td>in mm</td>
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<td>0.25</td>
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<tr>
<td>Nom. Meter Size (in)</td>
<td>Maximum Torque</td>
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<tr>
<td>72.0</td>
<td>190</td>
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</tbody>
</table>

All specifications per Customer requirements and in compliance with recognized standards such as: ANSI / AWWA/ DIN
**FM625**

**Gasket Installation**

1. Apply silicone grease or other viscous fixative to gasket for temporary positioning
2. Fit gaskets, checking to ensure it is perfectly centered
3. Poorly aligned gasket - can cause catastrophic leaks and flow errors
4. Carefully torque bolts with Bolt torque sequence above
   - 4 Bolt Pattern
   - 8 Bolt Pattern
   - See Table 4

**Sensor Position**

- Vertical (up-flow preferred to guarantee full-pipe condition)
- Horizontal

**Sensor Alignment**

<table>
<thead>
<tr>
<th>Sensor size Nominal Bore (in/mm)</th>
<th>Maximum Misalignment (in/mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 / 50</td>
<td>0.059 / 1.5</td>
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<tr>
<td>2-12 / 50-300</td>
<td>0.079 / 2</td>
</tr>
<tr>
<td>&gt;12 / &gt;300</td>
<td>0.157 / 4</td>
</tr>
</tbody>
</table>
**FM655**

**Gasket Installation**

1. Apply silicone grease or other viscous fixative to gasket for temporary positioning
2. Fit gaskets, checking to ensure it is perfectly centered
3. Poorly aligned gasket - can cause catastrophic leaks and flow errors

**Sensor Position**

- **Horizontal**
- **Vertical** (up-flow preferred to guarantee full-pipe condition)

- **Without Grounding Rings**
  - Gasket

- **With Grounding Rings**
  - Gaskets

**Figure 3.8**

**Figure 3.9**
3.8 Mounting in Unlined Metal Pipelines

Mounting in Plastic or Lined Pipeline, or where Conductivity < 20 micromhos/cm

Mounting in Pipes with Cathodic Protection

Connecting wire (not included), Must be adequately rated to carry cathodic currents

Flowmeter is electrically isolated from the piping

Grounding Figure 3.10
3.8 Grounding cont'd.

DC and AC voltages can be transmitted through conductive fluids which can lead to magnetic flow meter instrument errors. Adequate grounding between the liquid and the instrument is essential to ensure correct flow measurement. Magnetic flow meters should always be grounded at four places: 1) Flowmeter tube, 2) Transmitter, 3) Receiving instrument, 4) the fluid.

- External grounding rings should be installed on any meter where there is lined or non-conductive pipe or conductivity is less than 20 micromhos/cm. See Figure 3.10.

The grounding rings are in continuous contact with the process liquid providing a direct means for grounding electrical noise in the liquid. The electrical noise potential in the process liquid is at a similar level to the electrical ground plane to which the ac power supply ground is connected. This grounding method stabilizes the electrical field within the sensor measuring section permitting accurate flow detection. Grounding resistance must be less than 20 ohms.

- CONTACT OUR TECHNICAL SUPPORT GROUP IF PROCESS LIQUID NEEDS TO BE MAINTAINED AT A POTENTIAL ABOVE OR OTHER THAN GROUND.

3.9 NEMA 7 Electrical Connections

Unscrew the small blind cover of the electronics enclosure to gain access to the I/O PCB. Separate 3/4" NPT conduit entrances are provided for power and signal wiring. Conduit connections should follow good practice and should be routed from below the meter. If conduit cannot be routed from below, provide moisture traps and seals to prevent moisture from entering the meter enclosure. See Figure 3.11. Be sure to tighten conduit connections.

Watertight conduit, NEMA-6P fittings and seals are required to maintain the moisture-free integrity of all enclosures and electronics in the system. Entry of moisture may void Sparling’s warranty. All fittings must conform to NEMA-6P Classifications.
**3.9 NEMA 7 Electrical Connections cont’d.**

**CONNECTING POWER LEADS**

A connection diagram is located in the cover of the connection section and in Figure 3.12.

Connect power leads to terminal block TB401, terminals 14 (H), 13 (N), and 12 (G). Be sure to connect a good ground to terminal 12.

The Tigermag series is equipped with a switching power supply (standard which accommodates power sources of 77-265 Vdc 50/60 Hz). An optional 12-60 Vdc power supply is available. No adjustments or jumpers are required.

---

**Disconnect power before proceeding. Do not make connections while power is applied.**

---

**CAUTIONS REGARDING CONNECTING 4-20mA OUTPUT**

The Tigermag provides voltage to drive the 4-20mA output to your device. Only 4-20mA devices without external power supplies may be connected to the Tigermag.

If devices with external power supplies are connected to the 4-20mA output terminals, it will blow the power supply and void your warranty.
3.9 CONNECTING OUTPUTS

Determine which of the outputs (4-20mA, fault, flow direction, pulse or frequency) are to be used. Connectors for available outputs are also located on terminal block TB401 (see figure 3.12).

Check the position of the jumper on the I/O board (figure 3.12), placing the jumper as shown below for your desired output (figure 3.13).

After you have determined which of the outputs you require and have set the jumper position, you need to verify that the external load on the outputs is within the limits specified. Calculate the external load by summing the input resistance, including all interconnecting cable. Signal cable of 18-22 gauge is normally adequate.)

**External load limits**

- Analog output: 800 ohms max. impedance
- Totalizer Pulse output: 150 ohms min. impedance

Connect the required outputs as shown in figure 3.12. When driving inductive loads, install 1N4004 diodes across the load as shown in figure 3.14. If required connect the Positive Zero Return (PZR) input. Note that the meter output is forced to zero when terminals 4 and 5 are connected together through normally closed relay contacts.

Both outputs are floating and use the same isolated ground. If both outputs are used simultaneously, only one of the common legs can be grounded. If both are grounded, a ground loop will occur causing erroneous signals.

**CAUTION**

Only one load may have a leg strapped to ground unless the loads are isolated from each other.

**WARNING**

For proper operation – Mag-Command software MUST BE CONFIGURED to match your I/O selection. Refer to Appendix A, Section 1.8 Set Outputs.
REMOTE MOUNTING IS REQUIRED WHEN –
Remote mounting of the electronics is required when process temperatures exceed 212° F (100° C), when pipe vibration is excessive or when flooding is possible. Remote mounting should be used when high process temperatures exist at high ambient temperatures.

The standard interconnecting cable length is 15 feet. Shorter or longer cables should be ordered from the factory. The cable may be shortened in the field. **DO NOT SPLICE CABLE IN THE FIELD.**

When installing, provide moisture traps and seals to prevent moisture from entering the meter enclosure. Be sure to tighten conduit connections.

3.11 NEMA 7 Rated Junction Box

A bracket for wall or pipe mounting is furnished as part of the optional remote mounting kit. Interconnecting cable is supplied between the sensor and transmitter enclosure. Also supplied is a sensor mounted NEMA-7 rated junction box and a transmitter-mounted junction box in which coil and electrode connections are made.

**CAUTION**

DO NOT MAKE CONNECTIONS WHILE POWER IS APPLIED. DISCONNECT POWER BEFORE PROCEEDING.
Connect terminals 1 through 7 and ground both junction boxes with the special cable provided. See Figure 3.15. Installation in metal conduit is required for RFI protection as well as physical protection. See Figure 3.17. Also see Section 3.9 for input/output electrical connections.

Condensate draining through conduit CAN BE AVOIDED by using drip legs, drains and seals which will not let MOISTURE into the electrical enclosure.

WATERTIGHT METAL CONDUIT, FITTINGS AND SEALS ARE REQUIRED TO MAINTAIN THE MOISTURE-FREE INTEGRITY OF ALL ENCLOSURES AND ELECTRONICS IN THE SYSTEM. ENTRY OF MOISTURE MAY VOID SPARLING'S WARRANTY. ALL FITTINGS MUST CONFORM TO NEMA-6P CLASSIFICATIONS.

**WARNING**

FM and CSA approvals do not apply to remote-mounted transmitters nor to TEFZEL® lined meters.

NEMA-6P connections are REQUIRED to maintain accidental submergence proof rating of remote flow sensor.
A bracket for wall or pipe mounting is furnished as part of the optional remote mounting kit. Interconnecting cable is supplied between the sensor and transmitter enclosure. Also supplied is a sensor mounted NEMA-7 rated junction box and a transmitter-mounted junction box in which coil and electrode connections are made.

Watertight conduit, NEMA-6P fittings and seals are required to maintain the moisture-free integrity of all enclosures and electronics in the system. Entry of moisture may void Sparing's warranty.

All classifications must conform to NEMA-6P classifications.
NEMA 4X Remote Mounted Transmitter cont'd.
Open the NEMA-4X enclosure to gain access to the motherboard. Separate 3/4" NPT conduit entrances are provided for power and signal wiring at the bottom of the enclosure. Connect the required outputs as shown in Figure 3.19.

**CONNECTING POWER LEADS**
Connect power leads to Connector J1, terminals (H), and 2 (N). Be sure to connect a good ground to terminal 3 (G).

The Tigermag series is equipped with a switching power supply (standard which accommodates power sources of 77-265 Vac 50/60 Hz. An optional 12-60 Vdc power supply is available. No adjustments or jumpers are required.

---

**DisConnect power before proceeding. Do not make connections while power is applied.**

**CAUTIONS REGARDING CONNECTING 4-20mA OUTPUT**
The Tigermag provides voltage to drive the 4-20mA output to your device. Only 4-20mA devices without external power supplies may be connected to the Tigermag.

If devices with external power supplies are connected to the 4-20mA output terminals, it will blow the power supply and void your warranty.

**CONNECTING OUTPUTS**
Determine which of the outputs (4-20mA, fault, flow direction, pulse or frequency) are to be used. Connectors for available outputs are on connectors J3 and J4 (see figures 3.20 & 3.21).

After you have determined what outputs are required and you have set the jumper position, you need to verify that the external load on the outputs are within the limits specified. Calculate the external load by summing the input resistance, including all interconnecting cable. Signal cable of 18-22 gauge is normally adequate.

<table>
<thead>
<tr>
<th>External load limits</th>
<th>Analog output</th>
<th>800 ohms max. impedance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Totalizer Pulse output</td>
<td>150 ohms min. impedance</td>
</tr>
</tbody>
</table>

It is not necessary to install a diode across the load when driving inductive loads on the motherboard of the NEMA-4X electronics enclosure – it is however, required on the NEMA-7 I/O PCB. See Section 3.9 Connecting Outputs.
3.11

NEMA 4X Remote Mounted Transmitter

Output Connections

Figure 3.21

Sensor Junction Box

Remote PCB

NEMA-4X Remote Mounted Transmitter

Figure 3.22
4.0  SECTION IV - START-UP

Prior to applying power, the following checks should be made:

a) Check the flowmeter nameplate to insure that the power supply voltage is correct.
b) Verify that all electrical connections are correct. See Figures 3.12 and 3.15.
c) Check the polarity of external loads connected to the outputs.
d) Check to see that the two hall effect switches on the front of the transmitter are in place with the dark side of the switch facing up towards the LCD display. Do not remove these switches unless authorized by factory personnel. If you suspect that one of the hall effect switches is defective, contact the factory.

5.0  Calibration

All flowmeters are calibrated before leaving the factory. No field recalibration is required.

The 4 and 20 mA current level may be checked if desired by following the procedure in Appendix I DIAGNOSTICS. The meter can be used as a current calibrator to check connected equipment. See Appendix 1, para. 2.2.2.

6.0  Maintenance

No routine maintenance is required.
7.0

Troubleshooting

The following sections describe field tests and bench tests that can be performed on Sparling's magnetic flow meters.

7.1

General

Each flowmeter is rigorously tested during production. The final test stage is a wet flow calibration in a Sparling precision primary flow laboratory traceable to the National Institute of Standards and Technology (NIST).

Before troubleshooting, carefully verify the operating conditions of the meter:

1. Verify the interconnecting wiring by using a local milliammeter connected to the current output with no other load connected.
2. Verify that the sensor is completely filled with liquid. An empty or partially full sensor will continue to send a flow signal even with no flow.
3. Verify that any flow test comparison is valid before assuming that the meter is in error.
4. If in doubt, verify the conductivity of the liquid to see that it exceeds 5 micromho/cm.

7.2

Trouble-shooting Chart

The following trouble shooting chart should assist in correcting meter malfunction. For additional assistance, contact Technical Support 800/800-FLOW (626/444-057 in California).

a) "WARNING - EXPLOSION HAZARD - SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABILITY FOR CLASS 1, DIVISION 2";

"AVERTISSEMENT - RISQUE D'EXPLOSION - LA SUBSTITUTION DE COMPOSANTS PEUT RENDRE CE MATERIEL INACCEPTABLE POUR LES EMLACEMENTS DE CLASSE 1, DIVISION 2".

b) "WARNING - EXPLOSION HAZARD - DO NOT DISCONNECT EQUIPMENT UNLESS POWER HAS BEEN SWITCHED OFF OR THE AREA IS KNOWN TO BE NON-HAZARDOUS."

"AVERTISSEMENT - RISQUE D'EXPLOSION - AVANT DE DECONNECTER L'EQUIPMENT COUPER LE COURANT OU S'ASSURER QUE L'EMPLACEMENT EST DESIGNE NON DANGEREUX."
<table>
<thead>
<tr>
<th>SYMPTOM</th>
<th>POSSIBLE CAUSE AND CURE</th>
</tr>
</thead>
</table>
| 1. Erratic Reading (Output Wandering) | 1. A. Installation  
a. Is sensor properly grounded? A good liquid ground is required.  
b. Empty pipe? Pipe must be full of liquid.  
c. Air in pipe? De-aerate  
d. Chemical being injected upstream of flowmeter? Change the chemical dosage downstream of the flowmeter.  
B. Electrical  
a. VFD’s? Need additional filtering and improved grounding.  
b. Marginal Connection (particularly for remote units)? Rewire to insure good contacts.  
C. Moisture intrusion? Use leak tight fittings and keep the covers tight.  
D. Program errors? Default and reprogram. |
| 2. Inaccurate Reading            | 2. A. Run simulator test (47000/K). If not OK, reprogram.  
B. Coil drive blown? Electronic module has to be returned to factory for repair  
C. Mixed transmitters & sensors? Insure that sensor and transmitter has the same serial number. (This happens when you have more than one unit and the electronics are remote).  
D. Conductive coating? Clean sensor. |
| 3. Output Incorrect (Pulse & Analog) | 3. A. Disconnect wires and check circuit output with DVM. Reprogram current output. If program is OK, hardware failure, return to factory.  
B. For pulse output need oscilloscope. If there is flow no pulse output, hardware failure, return to factory. |
| 4. Analog Output Zero            | 4. A. No external power required, unit is not loop powered. If external voltage was connected, electronics are damaged and should be returned back to factory for repair. |
B. Cable PCB offset connector? Check connector is properly engaged |
| 6. Meter Reads Zero              | 6. Did it ever work?  
A. Blown coil drive? Return for repair  
B. Offset cable PCB connection? Properly engage connector.  
C. Not properly wired (remote units)? Re-wire correctly  
D. Conductive coating? Clean sensor. |
| 8. Display is turning black around edges | 8. Temperature is too high inside the enclosure. Relocate the meter or shield against the heat source. Continuing to power the meter in this condition will permanently damage the display. |
| 9. Display is difficult to read   | 9. Improve the lighting conditions if ambient light is dim. Remove large cover and adjust the pot directly below the display for best contrast while viewing from the intended viewing angle. |

If the above steps fail to correct the problem, try different flow rates and disconnecting loads temporarily and see if the problem persists. Perform simulator check and call the factory. Please have the following information available when you call:

- Meter serial number.
- Description of the problem. (Display, current output, totalizer/frequency, all of the above.)
- When does the symptom occur or repeat?
- What are the flow rates, the orientation of the meter in the pipeline, environmental conditions, output loads on the meter, pipe material and grounding technique?
- How did you verify the discrepancy?

Contact Technical Support 800/800-FLOW (in California 818/444-0571) for additional assistance.
Using the MAG-COMMAND™ magnetized screwdriver, enter programming mode by holding the magnet to the "NO" switch for five seconds, or until display changes state. See Appendix for detailed instructions. Answer NO to all prompts until the DIAGNOSTICS menu appears. Answer YES to the DIAGNOSTICS menu. Follow the menu instructions.

At this point, it will be necessary to remove the cover to gain access to the electrode cable PCB.

Remove the electrode cable PCB and rotate it 90 degrees as shown in Figure 7.2. Continue to follow the instructions in the menu. The meter will self-test, timing circuits and internal electronics. If it obtains the same values as were factory stored, it will answer “PASSED”. This confirms that the electronics are functioning correctly. Note: If running simulator in "operate" mode, 4-20 mA, pulse and display will go to \( \frac{47,000}{K} \). K = Meter Constant in pulses/gallon. K is found on the flowmeter data plate.
To remove the electronics module, first unscrew the larger enclosure cover and remove the screw fastening the module bracket. Now unplug the electrode cable PCB and coil cable PCB. See Figure 7.1, 7.2 and 7.3.

Grasp the module at each side and pull firmly while rocking the boards gently from side to side. **Do not pull the module out by the display.**

Meter electronics are contained in a plug in module. This module contains no user serviceable parts.

When re-installing the electronics module, observe the connector in the bottom of the electronics enclosure. Line up the electronics module with the connector. Plug in the replacement module. Plug in coil and electrode PCB’s. **Be certain the plug wires are routed properly and will not interfere with the housing cover. Don’t forget to replace the screw that fastens the module to the bracket.**

Apply power and observe display. Now, reprogram any values which were modified from factory preset levels. To obtain factory settings, look at meter calibration record shipped with meter. If not available, call factory with the serial number and request another copy of the meter calibration record.

The sensor consists of a measuring section with electrodes and coils in an aluminum or steel enclosure. The following paragraphs describe field tests that can be performed by the instrument technician. Defective sensors should be returned to the factory for repair. **OBTAIN A RETURNED GOODS AUTHORIZATION (RGA) PRIOR TO RETURNING MATERIALS TO PREVENT DELAYS.**
7.6 Coil Continuity Testing

**WARNING**

DO NOT MAKE OR BREAK COIL CONNECTION WHILE POWER IS APPLIED. DISCONNECT POWER BEFORE PROCEEDING.

Unplug coil cable plug. Using a short 22 gauge (or appropriate) test lead, connect ohmmeter between coil wires and measure resistance. See Figure 7.4A.

- **COIL RESISTANCE SHOULD MEASURE 270 OHMS 10%**.

If the coil resistance is too high or low (including open and short circuits) the sensor must be returned to the factory for inspection and/or repair.

7.7 Coil Insulation Test

Required test equipment: Insulation tester 10¹² ohm

Disconnect power and signal cables. Disconnect coil connector, Figure 7.4B. Connect insulation tester between coil wire and housing ground. Test the insulation at 500 Vdc. A reading below 10,000 meg ohms indicates moisture in the sensor. The sensor must be returned to the factory for inspection and/or repair.

Connect insulation tester between coil wire and housing ground. Test the insulation at 500 Vdc. A reading below 10,000 meg ohms indicates moisture in the sensor. The sensor must be returned to the factory for inspection and/or repair.

Remove sensor from the pipeline. Drain sensor and dry interior thoroughly. Unplug coil and electrode cable PCBs.

7.8 Electrode Circuit Continuity Test

Connect ohmmeter to E1 (center conductor of one electrode cable, see Figure 7.5) and to the electrodes which are accessible through the open sensor. Use the sensing electrodes which are located opposite each other in the center of the sensor. Do not use the grounding electrodes. Measure 0 ohms for one electrode and ¥ ohms (open) for the other. Connect ohmmeter to E2 and repeat the above procedure.
7.9 Electrode Circuit Insulation Test

This test must be performed with the sensor removed from the line and dry.

Unplug coil and electrode cable PCB.

Connect insulation tester three ways (see Figure 7.5.):

1. Between top post labeled E1 and shield.
2. Between center post labeled E1 and shield.
3. Between bottom post labeled E2 and shield.

Any leakage or fault indication will determine that the sensor should be returned to the factory for inspection and repair.

7.10 RS232 Interface Cable

Maintenance personnel who need to quickly configure several meters or spare electronics modules will appreciate the time saved by the ability to direct link to the Mag-Command menu structure, bypassing the Hall-effect switch/magnet interface.

Required equipment:

#553760 RS232 Interface Cable for the Tigermag 625/655
Any IBM compatible desktop or laptop computer
A 9-pin (female) to 25-pin (male) adapter cable
For DOS – Any dumb terminal communications software such as Crosstalk, or Procom
For Windows 3.x – Microsoft Terminal
For Windows 95 – Hyper Terminal

7.10.1 Setup

Setup is achieved in two steps: 1) connecting cables to the PC and configuring communications software and 2) connecting interface cable to the meter.

Connecting the Interface Cable to the Meter and PC (See illustration page 34)

- Make sure there is no power to the meter
- Remove the small cover (back of meter)
7.10

**RS232 Interface Cable cont'd**

- Remove any wiring that may be connected to the I/O PCB Terminals 1-11 (leave power connections in terminals 12, 13 and 14)
- Connect the four (4) pigtail leads on the cable end of the interface according to the numbers on the end of each lead to the proper terminal on the I/O of the Tigermag. For example, wire #4 goes to I/O PCB Terminal #4.
- Plug your 9 to 25-pin adapter cable into COM1 or COM2 of your computer
- Attach the 25-pin end of the Interface Cable to the 25-pin end of your adapter cable

**Configuring Communications Software**

**DOS**
- Turn on your computer, open your communications software and set the communications parameters for your COM port as follows:
  
<table>
<thead>
<tr>
<th>Baud rate</th>
<th>300</th>
<th>Start bit</th>
<th>7</th>
<th>Data bits</th>
<th>2</th>
<th>Stop Bits</th>
<th>Auto LF off</th>
<th>Duplex full</th>
<th>No parity</th>
</tr>
</thead>
</table>

  Apply power to your Tigermag. The display on the meter should read "PZR/PGM" and the display on the computer should read "AC POWER 60 HZ".

**WINDOWS 3.x**
- Apply power to your Tigermag. The display on the meter should read "PZR/PGM" and the display on the computer should read "AC POWER 60 HZ".

**WINDOWS 95**
- After plugging in the connectors, PZR/PGM should immediately appear on the screen.
- Select:  **START > PROGRAMS > ACCESSORIES > HYPER TERMINAL**
- Double click on the Hyper Terminal icon. Give the connection a name, i.e. Tiger Program.
- Click on "OK"
- Connect using "Direct to Com 1 (or Com 2)"
- Enter port settings:
  
<table>
<thead>
<tr>
<th>Baud rate</th>
<th>300</th>
<th>Start bit</th>
<th>7</th>
<th>Data bits</th>
<th>2</th>
<th>Stop bits</th>
<th>Flow Control</th>
<th>No Parity</th>
</tr>
</thead>
</table>

  Click on "OK" (NOTE: Save session for future use)
- Apply power to your Tigermag. The display on the meter should read "PZR/PGM", and the display on the computer should read "AC POWER 60 HZ".

**7.10.2 Maneuvering through Mag-Command**

- Hit “ENTER” on the keyboard. The screen on the computer should show “PZR/PGM”. Hit “ENTER” again. The display on the monitor should now be the same as that on the meter.
- The screen should show “SHOW METER DATA?” Enter “N” for no.
- The screen will show “PASSWORD = 0000”. Enter the password for the operation desired. If you make a mistake on keying a number, don’t panic. You can backspace to clear your error and enter the correct number as long as you are still on the password line.
- The MagCommand menus are the same as they appear when accessing them with the Hall-effect / magnet interface with the following Keyboard exceptions:
  
  | (SPACE BAR) | Steps over existing characters |
  | (BACKSPACE) | Clears characters |
  | (ENTER) or “Y” key | serves as “YES”, anything else as “NO” |
7.10.3 Problems - “I DON'T SEE ANYTHING”

- Are your connections tight?
- Did you power the Tigermag before engaging your communications program? If so, unplug and replug the Tigermag to get it to talk to the PC. The Tigermag should be the last thing powered.
- If you have more than one 9-pin COM port, have you chosen the right one? Try unplugging the Tigermag, close the programs, exit Windows (if you’re in it) and shut off your computer. Try the other COM port. Power up the computer, open your programs and finally power up the Tigermag.
- If these don’t help, call Sparling Technical Support at (818) 444-0571.

7.10.4 Using Microsoft Terminal

- Open Microsoft Windows. The icon for TERMINAL should be in the ACCESSORIES MENU GROUP. Open TERMINAL.
- Click on SETTINGS from the Menu Bar and select COMMUNICATIONS
- Check the following settings:
  Baud Rate for 300 Data Bits - 7 Stop Bits - 2 Parity - None
  Flow Control - None Parity Check - Leave box unchecked
  Connector - COM 1 or COM 2 (depending on your hardware)
  Carrier Detect - Leave box unchecked
- Click on OK to accept and update. Now power up your Tigermag. The display on the meter should read "PZR/PGM", and the display on the computer should read "AC POWER 60 HZ".

8.0 Replacement Parts List

<table>
<thead>
<tr>
<th>Description</th>
<th>Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Electronics Module, 77 - 265 Vac</td>
<td>552712</td>
</tr>
<tr>
<td>Electronics Module, 12 - 60 Vdc</td>
<td>552704</td>
</tr>
<tr>
<td>2. I/O PCB</td>
<td></td>
</tr>
<tr>
<td>12-60 Vdc</td>
<td>552738</td>
</tr>
<tr>
<td>77-265 Vac</td>
<td>552720</td>
</tr>
<tr>
<td>3. Fuse, Slo-Blo, (12-60 Vdc) 2.0 amp</td>
<td>148743</td>
</tr>
<tr>
<td>Fuse, Slo-Blo (77-265 Vac) 1.0 amp</td>
<td>148446</td>
</tr>
<tr>
<td>4. Kit, remote mount for Transmitter</td>
<td>552415</td>
</tr>
<tr>
<td>Assembly includes:</td>
<td></td>
</tr>
<tr>
<td>a) Mounting bracket</td>
<td>c) Cable grip</td>
</tr>
<tr>
<td>b) Tee mounting standoff</td>
<td>d) Sensor junction box (2)</td>
</tr>
<tr>
<td>5. Remote mount PCB</td>
<td>550071</td>
</tr>
<tr>
<td>6. Replacement remote mount cable</td>
<td>150721</td>
</tr>
<tr>
<td>(Replaces P/N's 139924 and 142860)</td>
<td></td>
</tr>
<tr>
<td>7. Grounding rings</td>
<td>Contact Factory</td>
</tr>
<tr>
<td>8. RS232 Interface Cable</td>
<td>553760</td>
</tr>
</tbody>
</table>

Your TIGERMAG™ can be fitted with an optional digital communication capability utilizing HART® protocol. In order to operate this feature, you must have a Sparling model KP601 transmitter interface. Consult factory for more details.

HART® is a registered trademark of Rosemount Inc.
Telzef® is a registered trademark of DuPont
Appendix 1
Programming Firmware Ver. 5.3 & Ver. 6.0

1.1 General

The 16 character alpha-numeric display is located directly above two magnetically operated Hall effect switches. The left switch is labeled "YES" and the right switch is labeled "NO". THESE SWITCHES ARE THE ONLY CONTROLS REQUIRED TO SELECT AND CHANGE PARAMETERS ON THE TIGERMAG. DO NOT ADJUST POTS.

The TIGERMAG is configured to the user's installation (programmed) using the MAG-COMMAND magnetic probe furnished with each meter. It can also be programmed with any high strength magnet. See Figure A1.1. Either switch is activated by momentarily holding the MAG-COMMAND probe close to the switch.

IT IS NOT NECESSARY TO OPEN THE ELECTRONICS COMPARTMENT IN ORDER TO CHANGE PROGRAM SETTINGS.

Refer to Figure A1.2 to determine how to get to each section of the program.

1.2 Entering Data

Alphanumeric data is required for the password and to enter or change constants. When data is required, the cursor will be positioned under the first character. A "NO" answer will cause the next valid character to be displayed in turn. A "YES" answer accepts the displayed character or digit and moves the cursor to the next position. After answering "YES" to the last character, you will be prompted with the entire data just entered. Answer "NO" if you wish to change. Answer "YES" when it is correct.

Your display may be either constant or an alternating display, like this:

```
COUNT=00001478
alternating with
100.000 GAL/COUNT
```

however, in this manual the meter display will be shown in a box like this:

```
102.7 GPM
```
13 Display Modes

Answer "YES" when the meter is in operation to toggle the display modes. A "YES" will change the display from showing flow rate (the default) to showing both rate and total alternately or showing the totalizer counter only.

- SHOW TOT
- SHOW RATE
- SHOW TOT RATE

14 Show Meter Data

Hold the MAG-COMMAND probe next to the "NO" switch for approximately 5 seconds. The meter will respond:

- SHOW METER DATA?
  a) Answer "YES" and the meter will display the model number, firmware version, serial number, tag number, K factor (pulses/gallon) liner and electrode material. As each data line is displayed a "YES" answer will display the next item. A 'NO' answer at any item (or lack of response for 12 seconds) will return the meter to the operating display.
  b) A failure to answer this prompt within a few seconds will automatically bring the PASSWORD menu. See Section 1.5.
  c) Answer "NO" and the PASSWORD prompt appears. A failure to enter a correct password will return the meter to operation.

15 Password Entry

To go beyond this point, a valid password is required. Every meter is shipped with the default password "0001". Any user with a valid password can change the password.

The meter password is entered by responding to each digit of the password with a "YES" or "NO". A "YES" moves the cursor under the next digit to the right. A "NO" scrolls to the next higher value for the underlined digit and then back to 0 again. The same 12 second time limit applies to each digit selection, i.e., a lack of response advances the cursor to the next position. Upon entry of a valid password, the meter enters a program mode and activates the fault output to signal remotely that programming is taking place.

▼ Default Password "0001"
RESCALE RATE?

A "YES" answer enters the Rescale Rate loop. A "NO" answer continues to the next menu item.

A menu is presented to select the engineering units in which rate is displayed and scaled. By answering "NO" each menu selection is presented in turn. A "YES" selection chooses the unit displayed and moves on to the next item.

1.6.1 Select Rate Units

RATE UNITS=GPM

An answer of "YES" will display the rate in "GPM". Otherwise answer "NO". A "NO" answer will bring the other pre-defined choices in turn, i.e., liters/min., cu. ft./sec., liters/sec., cubic meters/hour, million gallons/day, ft./sec., meters/sec. and "??". Answer "YES" to the predefined rate units or to "??". A "NO" to each item brings you back to the beginning of the loop. A "YES" answer is required to one of the selections to leave the loop.

Select one of the presented units of measure by answering "YES" and skip to Sec. 1.6.2. If no appropriate choice is displayed, select "???" and define your own units in 1.6.1a.

1.6.1a User Defined Rate Units

RATE UNITS=AAA

Note the cursor under the first A. Select the three alphabetic or numeric characters which you want displayed for your selected rate units by answering "NO" until the correct character is displayed in the current cursor position. A "YES" answer then accepts that character and moves the cursor one position to the right. A "YES" to the last character brings the conversion factor menu.

1.6.1b Conversion Factor

1=1.200000 GPM?

The conversion factor is defined as U.S. GPM/user unit. Enter the number of GPM which is equal to 1 of your selected units.

Example: To set the conversion factor for gallons per hour, enter the number of gallons per minute which is equal to 1 gallon per hour. One gallon per minute is equal to 0.016666 gallons per hour (1 ÷ 60). In this case, enter 0.016666.
1.6 Set Full Scale

The full scale flow rate defines only the flow rate at which the current output is set to 20 mA and at which the frequency output is set to 1000 Hz. It does not affect the display or the accuracy of the frequency or pulse output.

In the case above, entering 5.0 GPH here will set the current output to 20 milliamps when the fluid flow reaches 5.0 GPH. Full scale flow is selected in the units defined in 1.6.1 above. Thus, if “GPH” were defined, full scale would be defined in GPH not GPM. By answering “YES” or “NO” to each digit, it is possible to enter the full scale flow rate. A full scale below 1 FPS or above 35 FPS will receive a warning of “OUT OF RANGE LOW” or “OUT OF RANGE HIGH”. Unit is still functional, but is operating out of recommended range.

1.6.3 Select Rate as Percent of Full Scale

A “YES” answer will display flow in engineering units as defined in 1.6.2 "NO" displays rate as a percentage of full scale. Either choice will affect only the format of the display and nothing else.

1.7 Rescale Total

A “YES” answer enters the Rescale Total loop. A "NO" answer continues to the next menu item.

This is a warning that any change of totalizer scaling will automatically reset the internal totalizer(s). A “NO” answer ends this loop.

1.7.0 Count Direction

The internal totalizer can be programmed to totalize in the forward direction only or to totalize separately for forward and reverse.

Answer “YES” to count in the forward direction only (shown in the "operate" mode as "COUNT=")

Answer “YES” to have separate internal counters for forward and reverse flow (displayed as "F CNT=" and "R CNT=" respectively).
1.7 Select Total Units

A menu is presented to select the engineering units in which totalization or frequency is displayed and scaled. By answering "NO" each menu selection is presented in turn. A "YES" selects the unit displayed and moves on to the next item.

**TOT UNITS = GAL**

Answer "NO" to view the available pre-defined totalization units. Select "YES" to the preferred engineering units for totalization. One of the options will be `???.` This permits the definition of any desired units. A "YES" must be selected to one of the options to exit this loop.

1.7a User Defined Totalizer Units

**TOT UNITS = AAA**

Select the desired 3 character abbreviation as in 1.6.1a on the previous page.

1.7b Conversion Factor

**1 = 1.2500000 GAL?**

Enter the number of U.S. gallons which is equivalent to 1 of your selected units.

For example, the conversion factor from U.S. Gallons to Imperial Gallons is 1.25 because there are 1.25 U.S. Gallons to each 1 Imperial Gallon.

1.7 Set Registration

**R = 100.000 GAL?**

Enter the number of your engineering units of totalization which is equivalent to one count of the internal totalizer and external "TOT" output. This is normally an even number such as 0.1, 1, 10, 100, etc. In the above case 100 gallons will produce one totalizer pulse.

1.8 Set Outputs

This permits the selection of 4-20 or 0-20 mA dc outputs. Answer "YES" to the output desired. Most North American installations will use 4-20.

1.8.1 Select Pulse or Frequency

**OUTPUT: TOT**

This selects the totalizer output of 0-10 Hz 25/50/100 ms, 24 Vdc. The frequency output of 0-1000 Hz, 50/50 duty cycle is selected by answering "NO" to "OUTPUT: TOT" and "YES" to "OUTPUT: FREQ".

A jumper located on the I/O board under the small cover must be correctly set in the "totalizer" or "frequency" position. Be sure that connections are properly made for the selected outputs (see Figure 3.11). Set the jumper in the "open collector position" if an unpowered signal is preferred. Refer to page 18, Section 3.9, Electrical Connections.
1.8 Set Outputs Cont’d.

1.8.2 Set Flow Direction

This allows the user to reverse the normal flow direction. The default flow direction is from left to right as you face the display. If flow is in the opposite direction a minus sign (-) will appear in the display, the flow direction output will be active and the internal totalizer will be inhibited in the count forward direction. Apart from that, the meter will operate properly in either direction. Both pulse and analog outputs will operate in both directions. Answer ‘NO’ to reverse the normal flow direction.

1.8.3 Empty Pipe Detection (Optional)

Disabled on default, it must be enabled in the factory. It allows the user to set the EPD control between 0 (=off) and 9 as part of “SET OUTPUTS?” menu. Numerically, this represents approximate delay in seconds before the activation of EPD state (outputs driven to zero, totalizer on hold, message “OUTPUT INHIBITED” on display). Note EPD setting functions like a “volume” control, with “0” serving as an “EPD-off” click and “1” thru “9” enabling various levels of detection. Typical setting may be between 3 and 6, the lower the number, the higher the possibility of “false” detection of a single air bubble. Factory setting is “0” (off).

1.8.4 Hart Protocol (Optional)

Selects between “HART” and OFF if HART is installed.

1.9 Damping Adjustments

1.9.1 Display Damping

A “NO” answer scrolls from 0 (no damping) through 9 (maximum damping). Answer “YES” to the desired degree of display damping. Some experimentation may be necessary to obtain optimum results.

1.9.2 Current Damping

Current damping may be selected from 0-99 seconds. This corresponds approximately to the number of seconds to respond 90% of the way to a step change in input.
1.9 Damping Adjustments Cont’d.

1.9.3 Low Flow Cutoff

This is the minimum flow rate below which meter outputs are forced to zero. The number entered corresponds to the selected percentage of full scale as set for "Q" in Section 1.6.2. Choices range from 0 (low flow cutoff disabled) through 9%.

% ZERO CUTOFF = 2

1.9.4 Pulp Noise Suppression

This feature provides a method of rejecting noisy signals received at the electrodes. These signals are frequently associated with pulp flow such as found in paper processing or in juice processing.

Pulp noise rejection ignores any single flow signal which differs excessively from the preceding signal. As soon as two consecutive signals are received which are within the accepted range, the meter responds to the signal as being a true flow signal.

If pulp noise is encountered, select a suppression amount required to stabilize the signal. Zero is arbitrarily defined as disabling noise suppression. Nine is the highest noise suppression choice which corresponds to 30% above or below the previous signal. See Manual Section 1.4.3.

NOISE SUPP = 0-9

2.0 Exit Programming

A "YES" answer stores the changes which have been made and returns the meter to operation. A "NO" goes to the next menu item.

EXIT?

2.1 Change Password

Answer "NO" to return to CHANGE PASSWORD. Answer "NO" again to continue to the next item.

A "YES" answer permits changing the password by scrolling through the four available digits. Be sure to record the new password.

△ FAILURE TO RE-ENTER THE NEW PASSWORD WILL RESULT IN NOT BEING ABLE TO REPROGRAM AT A LATER DATE.
2.2 Diagnostics

Answer "YES" to enter the diagnostics loop. A "NO" answer returns to the RESCALE RATE menu.

WARNING—THE METER TOTALIZERS AND RATE WILL CEASE TO BE UPDATED WHILE YOU ARE IN THIS LOOP. OUTPUTS WILL BE HELD AT THEIR LAST VALUE. THE METER CONTINUES TO OPERATE HOWEVER.

2.2.1A Check HART Transmission (Ver. 6.0 when equipped)

Toggle between MARK and SPACE by selecting "NO". Enter next box by selecting "YES".

2.2.1B Check Coil Current (Perform this test last)

DISCONNECT POWER BEFORE PROCEEDING.

Remove cover from the electronics side of the transmitter housing. Connect a mA meter in series per diagram A 1.9. After connections are made, power the meter back up.

Enter password "0001" to enter programming loop. Select "YES" to step through menu choices until you reach the diagnostics menu.

Answer "YES"

STOP COIL DRIVE?

Answer "YES"

JUMPER E101 OUT?

Remove Jumper E101 per Figure A 1.8 then answer "YES".

COIL=HIGH

The mA meter should read a coil current of 80.00 mA ± 0.05 mA. If necessary, adjust pot VR to achieve this current. To test low coil, enter "NO".

COIL=LOW

The mA meter should read a coil current of -80 mA ± 0.05 mA. In necessary, adjust pot as VR to achieve this current. Enter "YES".

JUMPER REPLACED?

Reinstall Jumper E101 then answer "YES" to leave this test.
2.2 Answer "NO" to all options until you reach diagnostic main menu

Diagnostics
Cont’d.

Enter "YES" to exit programming.

▼ TO AVOID DAMAGE TO YOUR COIL DRIVER YOU MUST COMPLETE THE FOLLOWING STEPS:

DISCONNECT POWER.
DISCONNECT JUMPERS AND mA METER.
RESTORE ORIGINAL METER CONNECTIONS AND CLOSE METER HOUSING.
2.2.2 Check Current Loop

By answering "NO" the loop current can be scrolled by 1 mA increments, from 4 mA up to 20 mA and then back to 4. Answer "NO" to step to the next desired value. Answering "YES" at any time will exit the loop. Check the 4 mA and 20 mA positions with a digital milliammeter. Each should be accurate within ±0.02 mA (no damping is used).

The current output can also be used to test other equipment in the current loop such as recorders and controllers.

2.2.3 Simulator

Answer "YES" to enter the self test mode.

Rotate the electrode PCB to the test position. See Figure 1.10. Then answer "YES". The meter will then compare the signal level injected into the meter with that set by the factory.

The electronics are working satisfactorily.

The electronics are not operating accurately. Replace the electronics module. See Section 7.3.
11 General

The Factory set-up menu is available in only two instances:

- Recovery from "CHECK SUM ERROR".
- Installation of spare electronics modules (not factory calibrated).

- ALL NUMBERS SHOWN ARE EXAMPLES ONLY. CHECK YOUR METER RECORD TO FIND YOUR SPECIFIC VALUES.

- THE FACTORY SET-UP MENU SHOULD BE ACCESSED ONLY WHEN CONFIGURING SPARE ELECTRONIC MODULES TO A GIVEN FLOW SENSOR. CONTACT FACTORY FOR INSTRUCTIONS.

1.2 Factory Set-Up

In this menu, data is entered which customizes a universal set of electronics to the specific sensor. This is normally a factory function and is done in the field only when spare electronics are stocked in the field or when a "CHECK SUM ERROR" occurs. Note: Replacement ELECTRONICS ordered from the factory (not for stock purposes) are pre-programmed for a specific sensor serial number and will not require entry into the factory set-up loop.

Enter the programming loop as described in Appendix 1, 1.1-1.5

1.3 Setting the Calibration Constant "K"

Set "K" to the value stamped on the sensor nameplate.

1.4 Setting the Offset

Set '0' (the offset in Hz) to the correct value. The correct value of '0' is located on the Nameplate (S.N.H-16000000 and above) and on the meter data printout furnished with each meter. Select proper sign of the offset (+ or -) by replying "YES" to:

1.5 Exit

When replacing the electronics with another module from the same size sensor, exit at this point and the meter will function properly.

DO NOT PROCEED UNLESS:

- RECOVERING FROM "CHECK SUM ERROR" —or—
- Replacement electronics are supplied as a "spare" unprogrammed module —or—
- Replacement module is from a meter of a different size
1.6 Set Meter Data
This permits setting the model number, serial number, tag number, nominal meter size, liner, electrode material, actual diameter (see Figure A 1.5) and the coil frequency.

\[ \text{\textbf{NOTE: WHEN PROGRAMMING AN UNCALIBRATED SPARE, TAG NUMBER WILL READ "UNCAL SPARE". THIS MUST BE CHANGED IN ORDER TO PROTECT METER FROM UNAUTHORIZED OR ACCIDENTAL RE-ENTRY INTO FACTORY SET-UP MENU.}} \]

When the display reads:

```
SET METER DATA?
```

Answer “YES” to enter the SET METER DATA loop. Set each item from Tag or meter record until the display reads:

```
TAG: UNCAL SPARE
```

Answer “NO” to any character to change it. Change the tag to replace the word UNCAL SPARE with your own tag information. If you do not have tag numbers, simply remove the word “SPARE”.

\[ \text{\textbf{CAUTION: WHEN EXITING THE SET METER DATA LOOP, ACCESS TO THE FACTORY SET-UP MENU WILL NOT BE POSSIBLE.}} \]

1.7 Cal 4-20 Loop
\[ \text{\textbf{YOU MUST RECALIBRATE 4-20 mA LOOP WHENEVER "CHECK SUM ERROR" MESSAGE APPEARS.}} \]

Answer “YES” and the display reads ”LOSE OLD DATA?”. Now to set new calibration, connect an external digital current meter (DMM) to the current output in series with or in place of field wiring (If you were to answer "NO" the display would read "CALIBR UNCHANGED"). While display shows “SET 4MA OUTPUT”, hold the magnet over the "NO" and watch the current increase on the DMM. As it passes the 3.9 mA mark, apply brief magnet strokes to "NO" until the DMM reads 4.00 ±0.05 mA. Reply "YES" to that and to the prompt "OUTPUT=4MA?" that follows. A "NO" answer will restart the adjustment. The 20 mA level is set in the same manner.

1.8 Set Sim Level
A "YES" answer resets the stored values used by the simulator to confirm proper meter operation. The PCB must be rotated 90°. Answer "YES" if correcting a "CHECK SUM ERROR", otherwise answer "NO".

1.9 Set Gain Errors
Automatic ranging uses 8 gain levels. Each level can be individually trimmed in software to enhance \text{INTERCHANGEABILITY} of electronics. These gain levels require resetting when recovering from a "CHECK SUM ERROR". Set the gain correction to the data supplied with the meter. Also set "H", a slope correction factor.

\[ \text{\textbf{WHEN EXCHANGING ELECTRONICS, DO NOT CHANGE THESE CORRECTION FACTORS AS THE GAIN ERRORS AND "H" RELATE TO THE ELECTRONICS RATHER THAN THE SENSOR.}} \]

2.0 Finalizing
The meter will return to operation as soon as "H" is set.